1 *Per iteration,* CG has linear $(O(n))$ complexity because of its use of short-term recurrences.

Which of the following two-term recurrences depend on the property that $\underline{x}_k \in K_k(A; \underline{b})$?

$$\underline{p}_k \;=\; \underline{r}_{k-1} \;+\; \beta\underline{p}_{k-1} \tag{1}$$

$$\underline{x}_k \;=\; \underline{x}_{k-1} \;+\; \alpha\underline{p}_k \tag{2}$$

$$\underline{r}_k \;=\; \underline{r}_{k-1} \;-\; \alpha\underline{w}_k \tag{3}$$

2. Let $\underline{v} := [2\ 1]^T$, $\underline{w} := [3\ 1]^T$, and

$$A \;=\; \begin{bmatrix} 2 & -1 \\ -1 & 2 \end{bmatrix}.$$

What is the A-norm projection of $\underline{w}$ onto $\mathcal{R}(\underline{v})$?